REMARKS

The drawings have been objected to because it appears to the Examiner that Figures 1A and 1B should be labeled prior art. Correction was required, and the Applicant is tendering herewith corrected formal drawing Figures 1A and 1B labeled as prior art.

The disclosure was objected to because of the informality noted by the Examiner in the description of Figures 1A and 1B on page 8, lines 13-17. The Examiner will please note that by the proposed amendments to the specification that each of the descriptions of Figures 1A and 1B on page 8, lines 13-17, have been amended to reflect that those are prior art figures.

Claims 1-3 have been rejected under 35 U.S.C. §112, second paragraph, for the reasons set forth in numbered paragraph 3 of the Office Action mailed May 24, 2005. Applicant directs the Examiner's attention to the amendments that have been proposed to claims 1, 2 and 3, and to the reference numbers for the means for inducing phase change that are elements 12, 13 and 14, and the means for reducing vapor buildup that are elements 6, 7, 11, 17, 21, 22, and 23, as illustrated in Figure 7. Applicant believes that with this additional information and with the amendments that have been proposed to claims 1-3, the Applicant has addressed the Examiner's concerns expressed under 35 U.S.C. §112, second paragraph.

Claims 1-2 and 4-6 were also objected to because of the informality noted in paragraph 4 of the Office Action mailed May 24, 2005. The Examiner will please note that the informalities noted in numbered paragraph 4 of the Office Action mailed May 24, 2005, have each been dealt with, with one noted exception. The Examiner stated that in claim 1, lines 8 and 11, the statement that "at least ... device" is not consistent with language later appearing stating "at least one can." The Applicant does not understand the Examiner's concerns because if there

is at least one device then each device, even when there is only one, can be referred to with the word each and still make perfect sense. Applicant has not therefore addressed this particular concern of the Examiner, but the Examiner may find that with all other amendments made to claim 1 that the language at issue in paragraph numbered 4 of the Office Action mailed May 24, 2005, is no longer of concern to the Examiner.

Claims 1 and 3-6 have been rejected under 35 U.S.C. §102(b) as being clearly anticipated by Chrysler et al. Claims 1-2 have also been rejected under 35 U.S.C. §103(a) as being unpatentable over Chrysler et al. in view of Nakayama et al. For the reasons that follow, Applicant traverses these grounds for rejecting the claims of the present application.

The cooling geometry described in Chrysler et al. is fundamentally different from the claims of the present application for the reasons discussed below. While the geometry described in Chrysler et al. does include the use of a piston facing each chip, the role of the piston is simply to route the coolant to the chip surface. Also, the piston does not have to be thermally conducting and can therefore be made of plastic. In the present application, on the other hand, highly conductive studs are attached to the heat source (i.e., chip) and designed to conduct the heat from the heat source to the outer circumferential surface of the stud, were the heat is ultimately rejected to the coolant. These are two entirely different cooling configurations.

The cooling configuration in Chrysler et al. is also one of *perpendicular jet impingement* upon the surface of the chip. Note that the coolant impingement in the present application occurs against the outer surface of the stud, not the surface of the heat source (i.e, chip).

There are three forms of "heat transfer enhancement" that are commonly described in the heat transfer literature. The first is *single-phase enhancement*, where the liquid simply picks up the heat but remains in a liquid state. The second is *boiling heat transfer enhancement,* where

the liquid undergoes phase change to vapor as it picks up the heat. The third is *critical heat flux (CHF) enhancement*, where the coolant is supplied in such a manner as to delay burnout of the chip during very intense vapor formation. Chrysler et al. mentions only the first two types of enhancement, whereas the present application is intended primarily for the third.

The following are the fundamental differences between the cooling configuration described in Nakayama et al. and the present application.

The boiling configuration in Nakayama et al. is classified as *pool (or gravity-driven) boiling*, which relies entirely on buoyancy (density differences between the liquid and vapor) to achieve the motion of the primary coolant. The present application is properly classified as *flow (or forced convection) boiling*, where the coolant motion is achieved with the aid of an external mechanical pump.

The studs used in Nakayama et al. have a porous surface to aid in the bubble formation. The present application utilizes a multi-level enhancement scheme including millimeter-sized radial fins that play a vital role in the heat transfer enhancement.

In Nakayama et al., condensation of the vapor is achieved inside cavities surrounding the stud surface. The walls of these cavities are cooled indirectly by a secondary coolant. On the other hand, vapor in the present application is condensed within the liquid flow itself, aided by both high flow velocity and a liquid inlet temperature well below the boiling point. The studs used in Nakayama et al. are therefore not the equivalents of the radial fins of the present application, and a person of ordinary skill in this art would therefore not be able to combine Chrysler et al. with Nakayama et al. and come up with the novel radial fins of the present application.

For all these foregoing reasons, Applicant respectfully requests entry of the foregoing amendments, reconsideration of the present application in light thereof, and allowance of claims 1-6, as amended, over all prior art of record.

Respectfully submitted,

By: _____

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